

CH2M HILL Hanford Group, Inc.	Manual	Engineering
ENGINEERING CALCULATIONS	Document	TFC-ENG-DESIGN-C-10, REV A-6
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FUNCTIONAL AREA MANAGER:		C. Defigh-Price
DOCUMENT OWNER:		M. A. Knight

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1.0 PURPOSE AND SCOPE

This procedure describes the process for preparing, processing, and revising CH2M HILL engineering calculations. It also describes the process used by CH2M HILL to accept calculations completed by outside contractors and suppliers. This process applies to all engineering, design, process, or nuclear safety calculations prepared as engineering deliverables or as a part of another deliverable.

This procedure is implemented by CH2M HILL Engineering, Radiological Control, Nuclear Safety and Licensing, and Project Delivery.

2.0 IMPLEMENTATION

This procedure is effective on the date shown in the header.

3.0 RESPONSIBILITIES

Responsibilities are contained within Section 4.0.

4.0 PROCEDURE

See [Figure 1](#) for process flow diagram.

4.1 Determine Category of Calculation

Organizational
Manager

1. For CH2M HILL calculations, develop a list of calculations normally produced by the organization and assign to each calculation a category, using the criteria in [Table 1](#). (See Table 2 for a sample list of calculation types and associated categories.)

NOTE: Calculations are categorized as either formal (Section 4.2), informal (Section 4.3), or computation (Section 5.0) based on the potential impacts of an incorrect calculation. For both formal and informal calculations, Section 4.4 addresses computer software; Section 4.4.1, use of MathCad*, Section 4.4.2 use of Microsoft Excel; and Section 4.4.3, calculations embedded in other documents.

NOTE: If the use of Table 1 results in categorization as “computation,” then there are no further procedural requirements.

4.2 Formal Calculations

4.2.1 Preparation, Review, and Approval

Formally release the calculation as an engineering document into the Hanford Document Control System (see [TFC-ENG-DESIGN-P-25](#) or as part of another engineering document.

Organizational
Manager

1. Assign a qualified engineer or analyst to prepare the calculation.

*MathCad is a registered trademark of Mathsoft Engineering and Education, Inc., Cambridge, MA.

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2. Assign a qualified checker to review the calculation.

Engineer/Analyst

3. Prepare the calculation:

- a. Format the body of the calculation following the criteria given in Attachment A. Other sections may be added and the exact order of the sections is left to the engineer/analyst.

NOTE: Where calculations are prepared in support of documents that have their own procedural requirements and format, the document specific format requirements take precedence over the format requirements of this procedure, e.g., waste compatibility assessments (TFC-ENG-CHEM-P-13).

- b. Assign a unique title and obtain a document number from Hanford Document Numbering System ([HDNS](#)). To aid in retrievability, include key words that relate the calculation to the system, structure, component, area, project, or analogous terms.
- c. Prepare the calculation in a legible form suitable for reproduction, filing, and retrieval using the header shown in [Figure 2](#) for each page. Documentation of electronically generated calculation sheets (such as MathCad) are to use a format containing the same information as Figure 2.
- d. Provide the page number, the unique title, document number, and the revision number on each page of the calculation and on all attachment pages.
- e. Ensure that the calculation is prepared such that a technically qualified, independent person (e.g., checker) can repeat the calculation and come to the same conclusion without recourse to the engineer/analyst.
- f. Ensure that the results of the calculations are assessed for impacts on requirements and that appropriate changes to requirements in the affected requirements documents (e.g. System/Subsystem specifications and Operating Specification Documents) are initiated in accordance with TFC-ENG-DESIGN-C-06.

4. Forward hard or electronic copy (check copy) of the calculation to the assigned checker, along with any documents that directly affect the calculation, such as drawings, codes, standards, and related analyses.

Checker

5. Verify the calculation is technically accurate, suitable for the intended use, and compliant with this procedure, using Figure 3 as a checklist for key attributes.

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6. Review each page of the check copy of the calculation highlighting either on the hard copy or electronically any comments or changes required.
 7. Return the marked check copy of the calculation to the engineer/analyst. A Review Comment Record (RCR) form may be used.
- Engineer/Analyst
8. Resolve comments with the checker.
 - a. Make the agreed upon corrections.
 - b. Make a copy of the corrected calculation for the checker for back checking (if requested by the checker).
 9. For electronic calculations, once all comments have been resolved to the satisfaction of the checker, print a final copy of the calculation for signature.
- Engineer/Analyst and Checker
10. Sign and date, initial and date, or print name and date on each page of the calculation and complete the formal calculation review checklist ([Figure 3](#)) to signify that the resolution of review comments is complete and that the calculation complies with this procedure. Include the completed review checklist as a part of the calculation. Additional organization-specific review checklists may be included also.
- NOTE 1: For computer printout data (input or output files), complete Figure 2 as the cover sheet of the computer printout. Signature or name on subsequent pages of computer printout is not required. Pages that contain textual information but not actual calculations do not need signature or name. For example, when the numerical calculations are contained in an appendix and the objectives and methodology are contained in the main body of the document, only the pages of the appendix containing the calculations have signatures or names.
- NOTE 2: Where calculations are prepared in support of documents that have their own procedural preparation and review requirements, a document-specific review checklist may be substituted for the formal calculation review checklist provided in Figure 3. If no checklist is provided in the document-specific procedure, the checklist provided in this procedure shall be used.
- Engineer/Analyst
11. Prepare and sign an Engineering Data Transmittal (EDT) in accordance with [TFC-ENG-ADMIN-C-01](#); identify approval designators in accordance with [TFC-ESHQ-Q INSP-C-05](#).
- Checker
12. In situations where the design configuration depends on a calculation, ensure applicable design documents (e.g., drawings, ECNs, specifications) are consistent with the calculation.

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| Organizational Manager | 13. Review the calculation for compliance with procedural requirements and ensure that it is suitable for its intended use; sign the EDT form signifying that the engineer/analyst and checker are both qualified, the review was satisfactory, and that correct approval designators are used (TFC-ESHQ-Q INSP-C-05). |
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NOTE: For formal calculations, the engineer/analyst, checker, and organizational manager must be different individuals.

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| Engineer/ Analyst | 14. After all required review signatures are obtained, submit the EDT form containing the calculation to a Document Control Services Center in accordance with applicable procedures. |
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NOTE: Check copy does not have to be retained after calculation issue.

4.2.2 Revision of Approved Formal Calculations

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| Engineer/Analyst | <p>1. If an inadequacy or error is found in a calculation and the calculation is part of the design basis (referenced in a system design description that has been issued), notify the affected design authority and initiate a Problem Evaluation Request (PER) in accordance with TFC-ESHQ-Q C-C-01.</p> <p>2. If a revision is required such as update to the analysis, changes in assumptions, new data, resolve inadequacies or errors, or to close an engineering HOLD or TBD (see TFC-ENG-DESIGN-P-25), prepare a revision to the calculation by:</p> <ul style="list-style-type: none"> a. Correcting pages of the calculation to correct any erroneous, misleading, or unclear information b. For minor revisions, identifying such corrections within the calculation with a change bar in the right margin adjacent to the revised material c. For major revisions, changing the revision number or letter for the page to the new revision identifier for the calculation d. Updating change documentation as required by TFC-ENG-DESIGN-P-25, and TFC-ENG-DESIGN-C-06. |
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| Engineer/Analyst/
Checker | 3. Complete Section 4.2.1, steps 4 through 12. |
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| Organizational Manager | 4. Complete Section 4.2.1, step 13. |
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| Engineer/Analyst | 5. Complete Section 4.2.1, step 14. |
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4.2.3 Formal Calculations by Subcontractors

Calculations prepared by outside contractors or suppliers for CH2M HILL (non-shared resource) are prepared according to the quality assurance requirements identified in the procurement specification or subcontract and these calculations must be accepted by CH2M HILL. Acceptance by CH2M HILL is in addition to the subcontractor's quality assurance requirements. Calculations prepared by contractors or suppliers may be in a format similar to those prepared by CH2M HILL or may be embedded in a technical document or issued as a letter report. If the calculation is embedded in a technical document or issued as a letter report, it is especially important to ensure that relevant design assumptions and inputs are clearly identified and that the document is reviewed for acceptability in the same manner as if it were issued as a separate calculation. Acceptance of the calculations is required prior to relying on the results of the calculation or using an item that the calculations support. Calculations prepared for other projects that apply to the new design may be used instead of developing new calculations.

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| Organizational Manager | 1. Assign an engineer/analyst to review the calculation for release as a supporting document or directly into the Hanford Document Control System (HDCS) using an Engineering Data Transmittal (see TFC-ENG-DESIGN-P-25 , and TFC-ENG-ADMIN-C-01). |
| Engineer/Analyst | 2. Review the calculation to ensure applicability (consistent with the item the calculation supports), concurrence with assumptions and inputs, and reasonableness of results and conclusions; if discrepancies are discovered, return the calculation for rework before completing the review. |
| | 3. Prepare Figure 4 and sign it as checker indicating that the review was satisfactory. |
| Organizational Manager | 4. Review the calculation for suitability for its intended use and sign Figure 4 signifying that the engineer/analyst was qualified and that the calculation meets these requirements. |
| Engineer/Analyst | 5. Obtain any additional signatures and process in accordance with TFC-ENG-DESIGN-P-25 , or into the Hanford Document Control System using an Engineering Data Transmittal (TFC-ENG-ADMIN-C-01). |

4.3 Informal Calculations

The following sections represent the minimum requirements for informal calculations. The organizational manager may add calculation and release requirements to more closely resemble formal calculations.

4.3.1 Preparation, Review, and Approval

The calculation will usually be released as an electronic information file ([TFC-ENG-DESIGN-D-27](#)) or as an attachment to an ECN ([TFC-ENG-DESIGN-C-06](#)).

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Organizational Manager	1.	Assign a qualified engineer/analyst to prepare the calculation	
	2.	Assign a qualified checker to review the calculation.	
Engineer/Analyst	3.	Prepare the calculation:	
	a.	Format the body of the calculation following the criteria given in Attachment A. Other sections may be added and the exact order of the sections is left to the engineer/analyst.	
		NOTE: Where calculations are prepared in support of documents that have their own procedural requirements and format, the document-specific format requirements take precedence over the format requirements of this procedure, e.g., Waste Compatibility Assessments (TFC-ENG-CHEM-P-13).	
	b.	Assign a unique title, an identifier in accordance with Figure 2 , and, for release as an electronic information file (EIF), assign a unique title and identifier in accordance with TFC-ENG-DESIGN-D-27 . To aid in retrievability, include key words that relate the calculation to the system, structure, component, area, project, or analogous terms.	
	c.	Produce the calculation in a legible form suitable for reproduction, filing, and retrieval using the header shown in Figure 2 for each page. Documentation of electronically-generated calculation sheets (such as MathCad) are to use a format that contains the same information as Figure 2.	
	d.	Provide the page number, the unique title and identifier, and the revision number on each page of the calculation and on all attachment pages.	
	4.	Ensure that the calculation is prepared such that a technically qualified, independent person (e.g., checker) can repeat the calculation and come to the same conclusion without recourse to the engineer/analyst.	
	5.	Ensure that the results of the calculations are assessed for impacts on requirements and that appropriate changes to requirements in the affected requirements documents (e.g. System/Subsystem specifications and Operating Specification Documents) are initiated in accordance with TFC-ENG-DESIGN-C-06 .	
Engineer/Analyst	6.	Forward hard or electronic copy of the check copy of the calculation to the assigned checker along with any documents that directly affect the calculation, such as drawings, codes, standards, and related analyses.	
Checker	7.	Verify the calculation is technically accurate, suitable for the intended use, and compliant with this procedure, using Figure 3 as a checklist for key attributes.	

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8. Review each page of the check copy of the calculation highlighting either on the hard copy or electronically any comments or changes required.
 9. Return the copy of the calculation with any comments noted to the engineer/analyst.
- Engineer/Analyst
10. Resolve comments with the checker.
 - a. Make the agreed upon corrections.
 - b. Make a copy of the corrected calculation for the checker for back checking (if requested by the checker).
 11. For electronic calculations, once all comments have been resolved to the satisfaction of the checker, print a final copy of the calculation for signature.
- Engineer/Analyst and Checker
12. Sign and date, initial and date, or print name and date on each page of the calculation and complete the informal calculation review checklist ([Figure 4](#)) to signify that the resolution of review comments is complete and that the calculation complies with this procedure. Include the completed review checklist as a part of the calculation. Additional organization-specific review checklists may be included also.
- NOTE 1: For computer printout data (input or output files), complete [Figure 2](#) as the cover sheet of the computer printout. Signature or name on subsequent pages of computer printout is not required. Pages that contain textual information but not actual calculations do not need signature or name. For example, when the numerical calculations are contained in an appendix and the objectives and methodology are contained in the main body of the document, only the pages of the appendix containing the calculations have signatures or names.
- NOTE 2: Where calculations are prepared in support of documents that have their own procedural preparation and review requirements, a document specific review checklist may be substituted for the formal calculation review checklist provided in [Figure 3](#). If no checklist is provided in the document-specific procedure, the checklist provided in this procedure shall be used.
- Engineer/Analyst
13. Prepare an EIF in accordance with [TCF-ENG-DESIGN-D-27](#) or an ECN form in accordance [TFC-ENG-DESIGN-C-06](#).
- Checker
14. In situations where the design configuration is dependent on a calculation, ensure applicable design documents (e.g., drawings, ECNs) are consistent with the calculation.
- Organizational Manager
15. Review the calculation for compliance with procedural requirements and that it is suitable for its intended use.

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- a. For calculations issued into an EIF, sign the header on Page 1 of the calculation or
- b. For calculations issued with an ECN, sign the ECN form signifying that the engineer/analyst and checker are both qualified, the review was satisfactory, and that correct approval designators are used.

NOTE: For informal calculations, there must be at least two qualified persons completing the functions of engineer/analyst, checker, and organizational manager. Since the organizational manager will be the approver, the organizational manager may also be either the engineer/analyst or the checker, but not both.

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| Engineer/Analyst | 16. After all required review signatures have been obtained; forward the ECN form or EIF package containing the calculation to Records Information Management in accordance with TFC-ENG-DESIGN-C-06 or TFC-ENG-DESIGN-D-27 , respectively. |
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NOTE: Check print does not have to be retained after calculation issue.

4.3.2 Revision of Approved Informal Calculations

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|------------------------------|---|
| Engineer/Analyst | <ol style="list-style-type: none"> 1. If a revision is required such as update to the analysis, changes in assumptions, new data, resolve inadequacies or errors, or to close an engineering HOLD or TBD, prepare a revision to the calculation by: <ol style="list-style-type: none"> a. Correcting all pages of the calculation to correct any erroneous, misleading, or unclear information. b. For minor revisions, identifying such corrections within the calculation with a change bar in the right margin adjacent to the revised material. c. For major revisions, changing the revision number or letter for the page to the new revision identifier for the calculation. d. Updating change documentation as required by TFC-ENG-DESIGN-C-06 or TFC-ENG-DESIGN-D-27. |
| Engineer/Analyst/
Checker | 2. Complete Section 4.3.1, steps 4 through 14. |
| Organizational
Manager | 3. Complete Section 4.3.1, step 15. |
| Engineer/Analyst | 4. Complete Section 4.3.1, step 16. |

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4.3.3 Informal Calculations by Subcontractors

Calculations prepared by outside contractors or suppliers for CH2M HILL (non-shared resource) are prepared according to the quality assurance requirements identified in the procurement specification or subcontract and these calculations must be accepted by CH2M HILL. Acceptance by CH2M HILL is in addition to the subcontractor's quality assurance requirements. Calculations prepared by contractors or suppliers may be in a format similar to those prepared by CH2M HILL or may be embedded in a technical document or issued as a letter report. If the calculation is embedded in a technical document or issued as a letter report, it is especially important to ensure that relevant design assumptions and inputs are clearly identified and that the document is reviewed for acceptability in the same manner as if it were issued as a separate calculation. Acceptance of the calculations is required prior to relying on the results of the calculation or using an item that the calculations support. Calculations prepared for other projects that apply to the new design may be used instead of developing new calculations.

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|------------------------|--|
| Organizational Manager | 1. Assign an engineer/analyst to review the calculation for release as an EIF or into the Hanford Document Control System (HDCS). |
| Engineer/Analyst | 2. Review the calculation to ensure applicability (agreement with the item the calculation supports), concurrence with assumptions and inputs, and reasonableness of results and conclusions; if discrepancies are discovered, return the calculation for rework before completing the review. |
| | 3. Prepare Figure 4 and sign it as checker indicating that the review was satisfactory. |
| Organizational Manager | 4. Review the calculation for suitability for its intended use and sign Figure 4 signifying that the engineer/analyst was qualified and that the calculation meets these requirements. |
| Engineer/Analyst | 5. Obtain any additional signatures and process in accordance with TFC-ENG-DESIGN-D-27 or using an EDT in accordance with TFC-ENG-ADMIN-C-01 . |

4.4 Computer Software

Custom software or commercial off-the-shelf software (COTS) must meet the requirements of [TFC-BSM-IRM HS-C-01](#) prior to their use in engineering calculations, except for MathCad (Section 4.4.1) and Excel (Section 4.4.2).

4.4.1 Calculations Using MathCad

Calculations that use MathCad software must use the version available from HLAN. The calculation, including the portion generated by MathCad, is prepared and checked by following the sections of this procedure that pertain to the category of the calculation.

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4.4.2 Calculations Using Excel

Calculations containing Excel spreadsheets must use the version available from HLAN. The calculation is prepared by following the sections of this procedure that pertain to the category of the calculation. This section does not apply to spreadsheets used for “computations” as defined in Section 5.0 of this procedure. This section applies to repetitive use spreadsheets as well as single use spreadsheets used to perform engineering calculations. Verification of calculations using Excel spreadsheets is a two-step process.

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| Engineer/Analyst | <ol style="list-style-type: none"> Calculations performed using Excel must conform to Attachment A. <p>NOTE: Where calculations are prepared in support of documents that have their own procedural requirements and format, the document specific format requirements take precedence over the format requirements of this procedure, e.g., Waste Compatibility Assessments (TFC-ENG-CHEM-P-13).</p> |
| Engineer/Analyst/
Checker | <ol style="list-style-type: none"> Complete and document verification of spreadsheet portion of calculation in accordance with TFC-ENG-CHEM-D-33. Complete review process for the calculation as a whole using the sections of this procedure that pertain to the category of the calculation. |

4.4.3 Calculations Embedded in Text Document

This section identifies how to handle calculations included in text documents whose main purpose is not to perform the calculation itself. Such documents are prepared for many purposes including interpretation of calculation results, use of calculation results to make programmatic decisions, to support design descriptions, to support operational decisions, to support the safety basis documents and decisions, or to support environmental permitting documents and decisions. It is especially important for authors and reviewers of text documents to recognize when the document contains calculations and to ensure that the calculations meet the requirements of this procedure.

Calculations may be presented in text documents in one of three ways:

- Embedded in the main body of a document
- Included as an appendix to a document
- Prepared as separate document and included as a reference in the primary document.

The choice of how to present the calculation is based on consideration of the complexity of the calculation and the need for the reader to be able to view the calculation details within the primary document. The following table should be used as a guide in selecting the appropriate method of presentation for the calculation.

Reader Needs to View Calculation Details	Criteria	Method of Calculation Presentation
Yes	<ul style="list-style-type: none"> • Calculation is simple and easily performed. • Calculation has limited input data. • Calculation and results can be presented in two pages or less. • Presentation in main body does not detract from main purpose of document. 	Embedded
Yes	<ul style="list-style-type: none"> • Calculation is complex and more difficult to perform. • Calculation contains extensive input data. • Calculation is lengthy. 	Include as appendix
Yes	<ul style="list-style-type: none"> • Calculation meets criteria for embedded but inclusion in main body detracts from main purpose of document. 	Include as appendix
No	<ul style="list-style-type: none"> • Calculation meets criteria for embedded but it is desired not to prepare as a separate document. 	Include as appendix
No	<ul style="list-style-type: none"> • Calculation is complex and more difficult to perform. • Calculation contains extensive input data. • Calculation is lengthy. 	Prepare as separate document and include as reference
No	<ul style="list-style-type: none"> • Calculation may be referenced in other documents. 	Prepare as separate document and include as reference

5.0 DEFINITIONS

Computation. A computation is a simple calculation in which:

- Simple arithmetic is used
- Assumptions are not critical to the results
- A permanent record is not needed (i.e., it can easily be reconstructed)
- Special engineering expertise is not needed.

Examples of computations include length of a zip cord, areas and volumes, simple thermal expansion, and simple unit conversions. There are no procedural requirements for simple computations.

6.0 RECORDS

The following records are generated during the performance of the procedure:

- Calculation Packages.

The manager responsible for the calculation is also responsible for record retention and retirement in accordance with TFC-BSM-IRM_DC-C-02.

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7.0 SOURCES

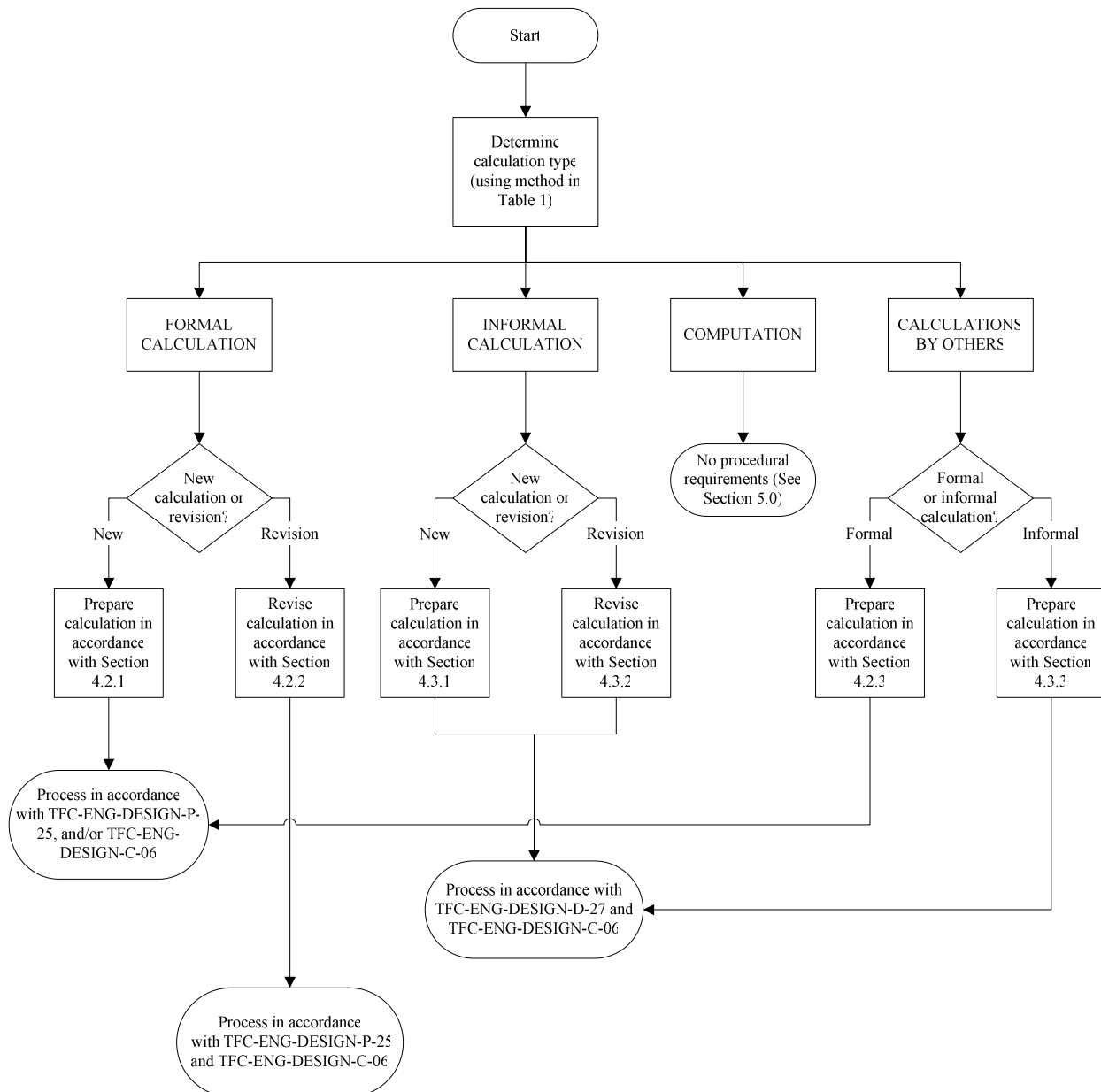
7.1 Requirements

1. [TFC-BSM-IRM_HS-C-01](#), "Software Development, Implementation and Management."
2. [TFC-PLN-02](#), "Quality Assurance Program Description."

7.2 References

1. [TFC-BSM-IRM_DC-C-02](#), "Records Management."
2. [TFC-ENG-ADMIN-C-01](#), "Engineering Data Transmittal Process."
3. [TFC-ENG-DESIGN-C-06](#), "Engineering Change Control."
4. [TFC-ENG-DESIGN-D-27](#), "Electronic Information File."
5. [TFC-ENG-DESIGN-P-25](#), "Engineering Document Control."
6. [TFC-ESHQ-Q_C-C-01](#), "Problem Evaluation Request."
7. [TFC-ESHQ-Q_INSP-C-05](#), "Independent Review and Approval of Documents."
8. [TFC-ENG-CHEM-D-33](#), "Spreadsheet Verification."

Figure 1. Calculation Process.



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Figure 2. Calculation Page Header.

Page ____ of ____

Title: Include a descriptive title for the calculation **Identifier:** Required for informal Rev: ____

Originator: Print **Date:** _____

Checker: Print **Date:** _____

Organizational Manager: Print and Sign (see note below) **Date:** _____

The header of each page of the calculation contains, as a minimum, the information shown above. Attachment A provides details on calculation format.

For informal calculations, an identifier as described below is included in the calculation header. Formal calculations do not require the subheading “Identifier” to be included on the first line of the header.

Assign an identifier, using the following format:

X-YY-ZZ, where

- X is the primary engineering discipline performing the calculation, using one of the following identifiers:
C = Civil/Structural/Environmental
E = Electrical
I = Instrumentation and control
M = Mechanical/Nuclear/Fire protection
N = Nuclear/Criticality safety
P = Process/Chemical
R = Radiological/Shielding
V = Ventilation/Heating/Air conditioning
- YY is the system identification number from H-14-020000 that the calculation supports.
- ZZ is the location identification number from H-14-020000 that the calculation supports.

NOTE: The signature line for Organizational Manager is required only on Page 1 of informal calculations to be issued into an EIF in accordance with TFC-ENG-DESIGN-D-27.

Figure 3. Calculation Review Checklist.

Calculation Reviewed: _____

Scope of Review: _____
(e.g., document section or portion of calculation)

Engineer/Analyst: _____ Date: _____

Organizational Mgr: _____ Date: _____

This document consists of _____ pages and the following attachments (if applicable):

Yes	No	NA*	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1. Analytical and technical approaches and results are reasonable and appropriate.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2. Necessary assumptions are reasonable, explicitly stated, and supported.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3. Ensure calculations that use software include a paper printout, microfiche, CD ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	4. Input data were checked for consistency with original source information.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	5. For both qualitative and quantitative data, uncertainties are recognized and discussed.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	6. Mathematical derivations were checked including dimensional consistency of results.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7. Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8. Software verification and validation are addressed adequately.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9. Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10. Conclusions are consistent with analytical results and applicable limits.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11. Results and conclusions address all points in the purpose.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	12. Referenced documents are retrievable or otherwise available.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	13. The version or revision of each reference is cited.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	14. The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	15. Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents as appropriate.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	16. All checker comments have been dispositioned and the design media matches the calculations.

Checker (Printed Name and Signature)

Date

* If No or NA is chosen, an explanation must be provided on or attached to this form.

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Figure 4. Subcontractor Calculation Review Checklist.

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Subject: _____

The subject document has been reviewed by the undersigned.

The checker reviewed and verified the following items as applicable.

Documents Reviewed: _____

Analysis Performed By: _____

- Design Input
- Basic Assumptions
- Approach/Design Methodology
- Consistency with item or document supported by the calculation
- Conclusion/Results Interpretation
- Impact on existing requirements
- _____

Checker (printed name, signature, and date)_____

Organizational Manager (printed name, signature and date)_____

Table 1. Determination of Calculation Category.

Use the following table to determine the minimum calculation category based upon risk criteria and importance factors.

NOTE: At a manager's discretion, any calculation category can be raised to a higher category but cannot be lowered.

Risk Criteria	Importance Factor *	Minimum Calculation Category
Nuclear Safety Classification of item supported by calculation	SC	Formal
	SS	Formal
	≤ GS	Formal, Informal or Computation (continue using following criteria)
Impact of incorrect calculation on program or operation of facility or project	H	Formal
	M	Formal or Informal (Manager Decision)
	L	Informal or Computation (Manager Decision)
Impact of incorrect calculation on facility or worker safety	H	Formal
	M	Formal or Informal (Manager Decision)
	L	Informal or Computation (Manager Decision)
Impact of incorrect calculation on environment and related regulations	H	Formal
	M	Formal or Informal (Manager Decision)
	L	Informal or Computation (Manager Decision)
Impact of incorrect calculation on radiological safety	H	Formal
	M	Formal or Informal (Manager Decision)
	L	Informal or Computation (Manager Decision)
Impact of incorrect calculation on potential for adverse client and/or stakeholder impacts and reporting	H	Formal
	M	Formal or Informal (Manager Decision)
	L	Informal or Computation (Manager Decision)

*** Legend:**

- GS = General Service
- SC = Safety Class
- SS = Safety Significant
- H = Critical Impact (could directly cause failure to meet risk criteria)
- M = Significant Impact (could have major influence on ability to meet risk criteria)
- L = Minor Impact (little or no influence on ability to meet risk criteria)

Table 2. Calculation Categorization.¹

CALCULATION TYPE	ASSIGNED CATEGORY	NOTES
Process Flowsheet	Informal	
Material Balance	Informal	
Data Review / Interpretation	Informal	
Instrument Set Point Analysis	Formal (supporting safety SSC or AC 5.15)	Informal for other types
Timecycle Analysis	Informal	
Airborne Emissions Estimates	Formal	
Fluid flow, pressure drop, control valve sizing	Formal	
Safety Basis calculations	Formal	
Flammable Gas calculations	Formal in support of SB	Informal for other types/data interpretation
Chemical Equilibrium modeling using ESP	Informal	Highly dependent upon knowledgeable user.
Process stream physical and chemical properties	Formal for SB	Informal for other applications
Compatibility assessment	Formal	
Criticality	Formal	Mostly done by subcontractor
Interim Stabilization Record Volumes	Formal	
Interim Stabilization Volumes	Informal	
C-200 Project structural	Formal for items affecting containment structures and OGT	Informal for other applications (SS and GS-M)
C-200 Project piping	Formal for OGT and back flow prevention	Informal for other applications (SS and GS-M)
C-200 Project electrical load analysis	Informal	(GS-M)
C-200 I&C analysis	Informal	Set point and control loads analyses (GS-M).
Bulk Vitrification Pre-conceptual Engineering	Informal (50% design) Formal (90% design) Formal (100% design)	Covers civil/structural, mechanical, electrical, HVAC, I&C, process and shielding
Bulk Vitrification Subsystem Specification	Computational	
Contact-Handled TRU Waste Packaging Subsystem Preliminary Engineering	Informal	Covers civil/structural, mechanical, electrical, HVAC, I&C, process and shielding

¹Any calculations categorized in this table that support Safety SSCs must be formal calculations. Categorization made per Table 1 (section 4.1) of this procedure.

Table 2. Calculation Categorization. (cont.)

CALCULATION TYPE	ASSIGNED CATEGORY	NOTES
Contact-Handled TRU Waste Packaging Subsystem RCRA Part B Permit	Formal	
Contact-Handled TRU Waste Packaging Subsystem Phase 2 Design	Formal	
Contact-Handled TRU Waste Packaging Subsystem Phase 3 Design	Formal	
Containerized Grout Pre-conceptual Engineering	Informal (50% design) Formal (90% design) Formal (100% design)	Covers civil/structural, mechanical, electrical, HVAC, I&C, process and shielding
Containerized Grout Subsystem Specification	Computational	
IDF Project Thermal Analysis or Liner/Transportation	Formal	PNNL: Performed under their own QA program and reviewed by PEs and DAs. (Regulatory – M)
IDF Project Transportation Analysis (Dose/Contamination)	Formal	Duratek: Performed under their own QA program and reviewed by PEs and DAs. (Regulatory – M)
IDF Project Structural Analysis of Equipment and Buildings	Formal	Performed under CH2M HILL's program: reviewed by PEs and DAs. (Regulatory – M)
IDF Project HVAC Analysis of Buildings	Informal	Performed under CH2M HILL's program: reviewed by PEs and DAs. (GS – L)
IDF Project Flow Analysis	Formal	Performed under CH2M HILL's program: reviewed by PEs and DAs. (Regulatory – M)
IDF Project Geotechnical Analysis of Soils	Formal	Performed under CH2M HILL's program: reviewed by PEs and DAs. (Regulatory – M)
IDF Project Civil Analysis of Liner	Formal	Performed under CH2M HILL's program: reviewed by PEs and DAs. (Regulatory – M)
IDF Project Electrical Analysis of Equipment/Loads	Informal	Performed under CH2M HILL's program: reviewed by PEs and DAs. (GS – L)
IDF Project Accident Calculations	Formal	TBD: Reviewed by PEs, DAs and Nuclear Safety. (Operational – M)

Table 2. Calculation Categorization. (cont.)

CALCULATION TYPE	ASSIGNED CATEGORY	NOTES
W-464 Project Electrical Loading Vault Instruments	Informal	Calculations will be performed by the A-E under their QA Program. A review by the PEs and the DAs will be conducted. (GS – L)
W-464 Project Vault Thermal Analysis of 2 and 3	Formal	Calculations will be performed by the A-E under their QA Program. A review by the PEs and the DAs will be conducted. (OCRWM/GS – M)
W-464 Project Shielding on MHM and Stacks	Formal	Calculations will be performed by the A-E under their QA Program. A review by the PEs and the DAs will be conducted. (GS – M)
W-464 Project Structural Calculations of Vault 2, 3, and Stacks	Formal	Calculations will be performed by the A-E under their QA Program. A review by the PEs and the DAs will be conducted. (SC)
C-104 WRS Process Flowsheet	Informal	Performed by the A-E and reviewed by the PEs and DAs
C-104 WRS Fluid Flow/ Pressure Drop	Formal	Performed by the A-E and reviewed by the PEs and DAs
C-104 WRS Electrical Loads/ Faults	Formal	Performed by the A-E and reviewed by the PEs and DAs
C-104 WRS Civil/Structural	Formal	Performed by the A-E and reviewed by the PEs and DAs
C-104 WRS Shielding/ALARA	Formal	Performed by the A-E and reviewed by the PEs and DAs
U-107 WRS Process Flowsheet	Informal	Flammable gas, material balance and retrieval duration. Performed by the A-E and reviewed by the PEs and DAs (Operational-M)
U-107 WRS Facility Civil/ Structural	Formal	Dome loading, piping supports and riser equipment. Performed by the A-E and reviewed by the PEs and DAs (GS-M)
U-107 WRS Pump System Structural	Formal	Performed by the A-E and reviewed by the PEs and DAs (GS-M)
U-107 WRS Shielding	Formal	Performed by the A-E and reviewed by the PEs and DAs (GS-M)
U-107 WRS Fluid Flow/ Pressure Drop	Formal	Piping and manifolds and hoses. Performed by the A-E and reviewed by the PEs and DAs

Table 2. Calculation Categorization. (cont.)

CALCULATION TYPE	ASSIGNED CATEGORY	NOTES
		(GS-M)
U-107 WRS Piping Heat Trace	Formal	Performed by the A-E and reviewed by the PEs and DAs (GS-M)
U-107 Water and Booster Pump Skid	Formal	Water heater sizing. Performed by the A-E and reviewed by the PEs and DAs (GS-M)
U-107 WRS Electrical Loads/Faults	Formal	Power system analysis, voltage drop and loads. Performed by the A-E and reviewed by the PEs and DAs (GS-M)
U-107 WRS I&C	Formal	Process monitoring manifold assembly. Performed by the A-E and reviewed by the PEs and DAs (GS-M)
U-107 WRS HVAC	Formal	Exhaust and heat/cooling loads. Performed by the A-E and reviewed by the PEs and DAs (GS-M)
U-107 WRS Water Lance Mechanical/Structural	Formal	Performed by the A-E and reviewed by the PEs and DAs (GS-M)
Lighting	Informal	
Heat trace sizing	Informal	Formal if supporting safety SSC
Instrument set point	Formal (supporting safety SSC or AC 5.15)	Informal for other types
Stress analysis, piping and components	Formal	
ASME Code Analyses	Formal	
Fluid flow, pressure drop, control valve sizing	Formal	
Tool/custom equipment evaluation (e.g., water lance, pump removal)	Informal	
Structural evaluation for temporary structures, e.g., tents, trailers	Informal	
Dome load Analyses of Record and load evaluations for tanks and pits outside the dome load limits	Formal	Other dome load calculations are computational

Table 2. Calculation Categorization. (cont.)

CALCULATION TYPE	ASSIGNED CATEGORY	NOTES
Structural analyses for tank riser loads, equipment supports on tanks and pits	Formal	
Structural analyses for piping, duct, and raceway supports, equipment racks, and panel supports	Formal	
Structural analyses for lifting bail program	Informal	
Evaluations of hoisting and rigging for below-the-hook lifting devices	Formal (per ANSI B30.20)	
Evaluations of hoisting and rigging except below-the-hook lifting devices	Informal	
Structural analyses, general, including reinforced concrete, timber, steel structures	Formal (if using ANSYS, STAAD, or similar software)	Informal for other types unless mission critical or supports client/regulatory commitments
Unit conversions done using Excel or other computational tool	Computational	
Calculations that support FSAR/DSA/JCO	Formal	
Calculations that are part of Technical Basis Documents	Formal	
Calculations to support Unreviewed Safety Question Evaluations	Formal	
Waste Compatibility Assessments	Formal	
Chemical Addition Volume Calculations	Formal	
Spreadsheets for Evaluation of Caustic Limits and Quarterly Chemical Control Program	Formal	
Process Control Plan	Informal	Formal if supporting Safety SSC or TSR compliance
Post Run Calculation	Informal	Formal if supporting TSR compliance
Criticality Safety Representative Determinations	Informal	
Electrical Load Study	Formal	Includes load, voltage, fault current/power, motor starting, and coordination of protective devices

Table 2. Calculation Categorization. (cont.)

CALCULATION TYPE	ASSIGNED CATEGORY	NOTES
Lighting	Informal	
Heat trace sizing	Informal	Formal if supporting safety SSC
Instrument set point	Formal (supporting safety SSC or AC 5.15)	Informal for other types
Stress analysis, piping and components	Formal	
ASME Code analyses (e.g., fatigue, creep, thermal, vibration, heat transfer)	Formal	
Fluid flow, pressure drop, control valve sizing	Formal	
Tool/custom equipment evaluation (e.g., water lance, pump removal)	Informal	
Structural evaluation for temporary structures, e.g., tents, trailers	Informal	
Analyses for DOT waste shipping containers	Formal	
Fall protection anchor points	Formal	Requires OSHA qualified person
Dome load Analyses of Record and load evaluations for tanks and pits outside the dome load limits	Formal	Other dome load calculations are informal
Structural analyses for tank riser loads, equipment supports on tanks and pits	Formal	
Structural analyses for piping, duct, and raceway supports, equipment racks, and panel supports	Formal	
Structural analyses for lifting bail program	Informal	
Evaluations of hoisting and rigging for below-the-hook lifting devices	Formal (per ANSI B30.20)	
Evaluations of hoisting and rigging except below-the-hook lifting devices	Informal	
Structural analyses, general, including reinforced concrete, timber, steel structures	Formal (if using ANSYS, STAAD, or similar software)	Informal for other types unless mission critical or supports client/regulatory commitments

Table 2. Calculation Categorization. (cont.)

CALCULATION TYPE	ASSIGNED CATEGORY	NOTES
Large-scale computer environmental impacts calculations performed by contractors under direction of Environmental Engineering Staff	Formal	Statement of Work requires subcontractor to perform detailed review of computer code, input decks and output. CH2M HILL staff review choice of code, verification and validation of code, input cases to be run, output results and documentation
Small scale computer code calculations to provide input to the large-scale computer codes (above)	Informal	Statement of Work requires subcontractor to provide complete review of computer code, input decks, and output
Post-processing codes used for Environmental/Vadose zone calculations.	Informal	Statement of Work requires subcontractor to provide complete review of computer code, input decks, and output.
Excel spreadsheets used to support environmental/Vadose zone data evaluation	Informal	
Unit conversions done using Excel or other computational too.	Computational	
Critical Lift package calculations	Formal	using calculation process validated by the Design Authority
Dome Loads	Computation	
Vent and Balance calculations		pre-set equations
Stack Flows, aerosol tests	computations	
Calculation Notes	Formal	
Technical Basis Documents	Formal	
Calculation attached to USQ-D		Treat as "General Service" because USQ-Ds do not determine safety classifications or accident controls
Calculation attached to an Internal Memo		Treat as "General Service" because informal calcs attached to a memo do not determine safety classifications or accident controls

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ATTACHMENT A - CALCULATION FORMAT AND PREPARATION INSTRUCTIONS (FORMAL AND INFORMAL CALCULATIONS)

Include the following sections in the body of the calculation that are marked “required.” Other sections may be added as needed and the exact order of the sections is optional.

1. Objective/Purpose (required)

Describe the objectives (including the required end products) of the analysis including a problem statement. Describe the analysis performed in the calculation.

2. Summary of Results and Conclusions (optional depending on calculation length or complexity)

For lengthy or complex calculations, summarize the results and conclusions contained in later sections, highlighting the key points.

3. Introduction/Background (optional)

Provide any background information needed to understand the calculation purpose.

4. Input Data (required)

Information that serves as input to the calculation must be referenced to the source.

Information used to produce a hand calculation or used as input for a computer code must be explicitly stated, or be included in an attachment that will stay with the calculation. (It is not intended that impractical attachments, such as voluminous databases, be included.) Extensive compilations of input data used in more complex calculations may be better contained in separate appendixes.

Data files used in computer codes, with associated release numbers or dates, shall be listed. Enough information shall be included in the report to allow a complete reconstruction of all the input cases. This may include publishing all input files used to reach the conclusion(s) in the calculation.

Data and information used as input to the calculation shall be referenced to the source. Copies of reference information should be made available to the checker and Organizational Manager to simplify the review and approval process.

Information or data used to produce a hand calculation or used as input to a computer code or spreadsheet shall be included in an attachment. In the case of voluminous data from databases registered in Hanford Information System Inventory (HISI); reference can be made to the specific query, specific spreadsheet, date of query, column and range of data used in the calculation.

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ATTACHMENT A - CALCULATION FORMAT AND PREPARATION INSTRUCTIONS (FORMAL AND INFORMAL CALCULATIONS) (cont.)

Where spreadsheets are used in support of calculation preparation, document the sources of the input data in this section and complete verification that input data is correctly entered in accordance with [TFC-ENG-CHEM-D-33](#).

In documenting input data, preference should be given to providing the information in a numbered list format with a description of the type of input data used and the reference that it was taken from.

5. **Assumptions** (required if assumptions are made)

Explicitly state or reference assumptions used in the analysis along with supporting data or information. Assumptions that are stated must be used within the calculation. At a minimum:

- a. List key assumptions that must be verified prior to relying on the calculation for operation (e.g., those providing a basis for selection of Technical Safety Requirements and safety structures, systems, and components). Engineering HOLD or To Be Determined (TBD) notations for missing information must be controlled in accordance with TFC-ENG-DESIGN-P-25.
- b. Clearly state assumptions resulting from engineering judgment with the basis for that judgment.

6. **Method of Analysis** (required)

The methodology needs to “stand alone” in quality and completeness so that a reasonably knowledgeable person would not have to seek the originator’s input on the methodology used in order to arrive at the same conclusions. Provide a brief description of the method of solution, numerical computations, and identification of the source or derivation of all equations that are not common usage. The methodology should use recognized national standards wherever possible with clear derivation of or reference to equations and any limitations on their use. Variables in equations need to be clearly defined.

If a formulation has been taken from an unpublished reference (such as an internal memo) or was developed by the engineer/analyst, the validity of the model or correlation must be demonstrated. The engineer/analyst must ensure that the uncertainties thus introduced will not impact the conclusions of the document. The actual numerical calculations may be included in this section where practical. Complex calculations or spreadsheets not readily contained within the body of the calculation are better contained in separate appendices.

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ATTACHMENT A - CALCULATION FORMAT AND PREPARATION INSTRUCTIONS (FORMAL AND INFORMAL CALCULATIONS) (cont.)

Information necessary to reconstruct the analysis, including hand calculations, must be included.

Where repetitive use spreadsheets are used, their methodology should be documented in a published formal engineering calculation prepared in accordance with this procedure. Subsequent calculations performed with the repetitive use spreadsheet would then reference that calculation in this section for a full description of the methodology.

Where single use spreadsheets are used, their methodology should be described in this section or in a separate appendix.

7. Use of Computer Software (required if software is used)

Documentation of computer codes shall include program name, version numbers, release dates, references to user manuals, and program verification data. If the calculation uses software that has previously been documented and verified in an engineering calculation, that calculation may be referenced. The new calculation must contain documentation that the previous verification is applicable.

If the calculation is performed by a spreadsheet (Excel) application verification shall be performed in accordance with [TFC-ENG-CHEM-D-33](#). The following information shall be included, as a minimum, in this section for each spreadsheet used in support of the calculation:

- Spreadsheet name
- Spreadsheet Owner
- Location of spreadsheet
- Spreadsheet Verification File Number

8. Results (required)

Describe the results obtained. The number of significant figures reported shall be consistent with the quality of the data and with its purpose.

9. Conclusions (required)

Describe the degree to which the objectives and purpose have been met along with information on the appropriateness and completeness of the results for the intended purpose.

10. Recommendations (optional)

List the recommendation(s) including basis information.

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**ATTACHMENT A - CALCULATION FORMAT AND PREPARATION INSTRUCTIONS
(FORMAL AND INFORMAL CALCULATIONS) (cont.)**

11. References (required)

Examples of references include drawings, reports, change notices, manuals, publications, codes, and standards. Provide the title, author (or company), and revision number or publication date, if available. References that may not be retrievable in the future, particularly informal communications that contain critical supporting information, shall be added to the document as attachments. The engineer/analyst must be able to supply the reviewer with a copy of any document cited in the analysis. If this calculation will support analyses that will be presented in the Tank Farm Contractor safety basis, a copy of all references cited shall be forwarded to the Safety Basis Library for future use.

12. Attachments and Appendixes (optional)

Include additional information such as computer software documentation (including spreadsheet printouts), calculation review checklist(s), spreadsheet verification form(s), detailed calculations not readily contained in the main body, extensive compilations of input data, inspection reports, and copies of references, memos, or pages of manuals.